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A white species of *Volvariella* (*Basidiomycota*, *Agaricales*) from southern China

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Abstract — A new white agaric, *Volvariella nivea*, discovered in Guangzhou of China is formally introduced. Similar species are compared, and morphological characters and the rDNA ITS sequence of the new species differ from all other taxa placed in *Volvariella*. The holotype is deposited in the Herbarium of Microbiology Institute of Guangdong (GDGM).

Key word — *Pluteaceae*, taxonomy

Introduction

Spegazzini (1899) established *Volvariella* Speg. to accommodate species with pink basidiospores, free lamellae, and a stipe lacking an annulus but encased by a basal volva. Many species have been transferred to this genus from several genera, including *Volvaria* (Fr.) P. Kumm., *Volvariopsis* Murrill, *Pseudofarinaceus* Earle, *Agaricus* L., and *Pluteus* Fr. New taxa are regularly being reported from tropical, subtropical and temperate regions of both eastern and western hemispheres. Until now, 111 species names have been recorded (www.Indexfungorum.org), including 19 species reported from China (Teng 1963, Tai 1979, He & Feng 1987, Bi et al. 1993, 1997, MEXM 1997, Mao 1997, Huang 1998). In 2008, a *Volvariella* species was collected from Baiyun Mountain in Guangzhou Municipality of China that differs from previously named species. The new species is formally described below.

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Materials and methods

Specimens were annotated and photographed in the field, dried in an electric drier, and then deposited in herbarium. Fungal tissues were mounted in 5% KOH for microscopic examination. Lengths and widths of 30 randomly selected spores were measured from spores deposited on a slide; 'av.' represents the average length and width values and 'Q' the mean length/width ratio. Light micrographs were taken using a Nikon Eclipse 80i trinocular phase contrast microscope and the scanning electron micrographs taken on a Philips FEI-XL30 scanning electron microscope. Colour designations within parentheses follow Kornerup & Wanscher (1978). The holotype is deposited in the Herbarium of Guangdong Institute of Microbiology (GDGM).

Genomic DNA was isolated from dried specimens and the ITS1-5.8S-ITS2 segment from the ribosomal DNA (rDNA) was amplified with primer sets ITS4 (5'-TCC TCC GCT TAT TGA TAT GC -3') and ITS5 (5'-GGA AGT AAA AGT CGT AAC AAG G-3') by polymerase chain reaction (PCR) techniques (White et al. 1990). Amplified products were examined with agarose gel electrophoresis using a 2kb DNA marker. The amplified PCR products were directly sequenced and deposited in GenBank.

Taxonomy

Volvariella nivea T.H. Li & Xiang L. Chen, **sp. nov.** Figs. 1-7

MycoBank MB 513096; GenBank FJ749127

Pileus 7–9 cm latus, campanulatus, conicus vel late convexus, albus, fibrillosus, sericeus, estriatus. Contextus albus, immutabilis, 5 mm crassus ad stipitem. Lamellae liberae, juvenili albidae, deinde incarnatae, ventricosae, 5–7 mm latae. confertae, lamellulis intermixtae. Stipes 10–11.5 × 0.7–0.8 cm., cylindricus, aequalis vel deorsum leviter incrassatus, pubescens vel villosus, deorsum glabrescens, albus. Volva alba, lobata, glabrous. Sapor et odor mitis. Basidiosporae (5.2–)6.0–7.0(–8.0) × (4.0–)4.5–5.5 (–6.0) µm ovoideae vel late ellipsoideae, laeves, dilute roseae. Basidia 25–33 × 10–12.5 µm, clavata, hyalina, (2–)4-sporigera. Pleurocystidia 60–132 × 19–44 µm, fusoidea vel ventricosa, raro ovoidea lanceoloidea vel subcylindrica. Cheilocystidia similares ad pleurocystidia, 50–150 × 20–46 µm. Hyphae defibulatae. Ad terram humosam in silvis.

Holotype: *China, Guangdong Province, Guangzhou Municipality, Baiyun Mountain, 22 June 2008, T. H. Li & Xiang L. Chen GDGM 25489.*

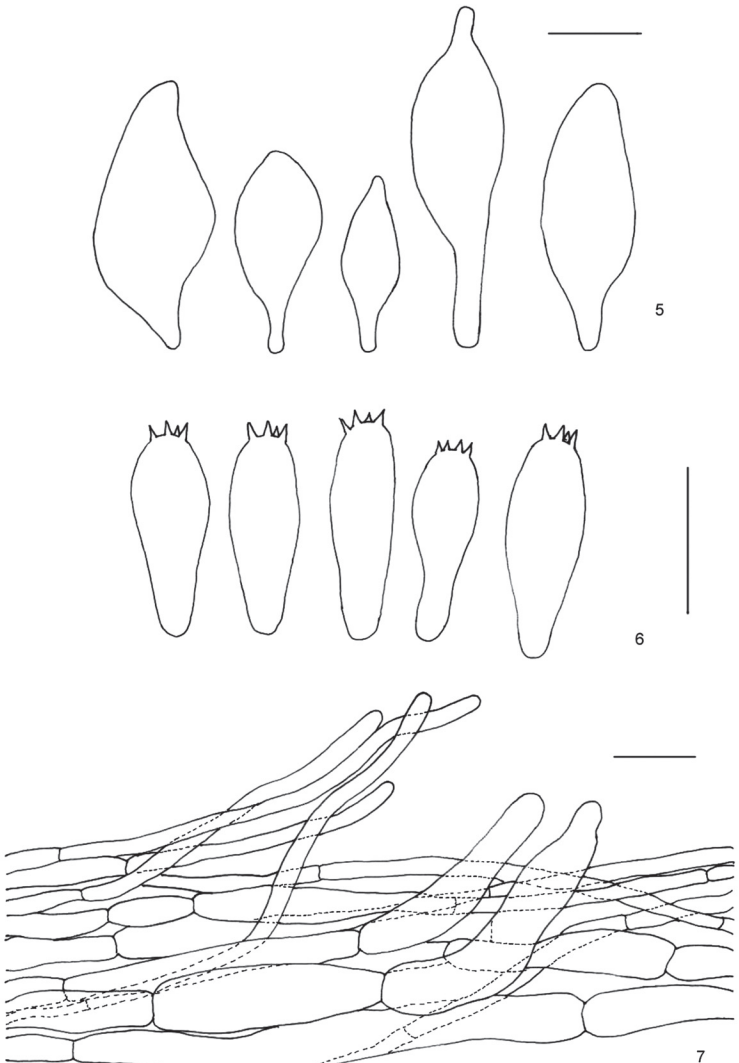
Etymology: The epithet nivea refers to its snow white colour.

Pileus 7–9 cm broad, fleshy, campanulate, conical to broadly convex, with a flattened disc, snow-white (10A1), fibrillose, not viscid; margin very thin, entire, non-striate, when mature with pinkish tint apparent from the pink lamellae beneath. Flesh thin, 5 mm thick near stipe, soft, white, unchanging when injured. Lamellae free, white (10A1) when young, becoming flesh-colour or pinkish to pink (10A2, 10A3), ventricose, moderately crowded, 8–9 per cm at pileus margin, 5–7 mm broad, with lamellulae; edge entire to slightly

Figs. 1–4: *Volvariella nivea* (GDGM25489). 1–2. Basidioma; 3–4. Basidiospores.
Bars: 1 = 20 mm; 2 = 20 mm; 3 = 5 μm; 4 = 10 μm

serrulate or pruinose. Stipe 10–11.5 × 0.7–0.8 cm., central, cylindrical, equal to slightly enlarged downwards, pubescent to weakly fibrillose, slightly silky striate, both surfaces pure white. Volva free from the stipe, ample, fleshy, pure white, lobed. Taste and odour mild.

Basidiospores (5.2–)6.0–7.0(–8.0) × (4.0–)4.5–5.5(–6.0) μm (av.=6.5 × 5.0), Q=(1.10–)1.15–1.41(–1.50) (av.=1.28), ovoid to broadly ellipsoid, smooth, with a stramineous or salmon-coloured, thickened wall. Basidia (2–)4 spored, 25–33 × 10–12.5 μm, clavate, hyaline; sterigmata 1–2 μm long. Pleurocystidia 60–132 × 19–44 μm, clavate, fusoid to fusoid-ventricose, sometimes ovoid or obovoid, usually constricted at base, with an acute or obtuse apex, sometimes with an elongate neck, thin-walled, hyaline. Cheilocystidia 50–150 × 20–46 μm, similar to pleurocystidia. Lamella trama inversely bilateral, with hyphae 6–20 μm broad, thin-walled, hyaline. Pileus trama with hyphae 9–35 μm



Figs. 5–7: *Volvariella nivea* (GDGM25489). 5. Pleurocystidia and cheilocystidia; 6. Basidia; 7. Pileipellis.
Bars: 5 = 40 μm; 6 = 20 μm; 7 = 25 μm

broad, thin-walled, hyaline. Pileipellis non-gelatinous, with hyphae 7–22 μm broad, colourless. Volval remnants made up of filamentous hyphae, with cells 32–56 × 7.5–15 μm inside, and with more inflated cells 28–54 × 14.7–24.5 μm

at the both outer and inner surfaces, colourless. Clamp connections absent in all tissues.

Habit, habitat, distribution and season—Solitary on humus and debris under bamboo mixed with other broadleaf trees; China (Guangzhou). June.

Comments— Another specimen (GDGM 26364), collected on 18 June 2009 from the type locality with a 12.5 cm broad pileus and 16 × 1.0 cm diam stipe, was a slightly larger than the type. The remaining characters are otherwise identical to the type.

Volvariella nivea is characterized by its terrestrial habit, pure white basidiomata, a fibrillose pileus, and relatively small basidiospores that are smaller than those of most white *Volvariella* species. The new species is classified in stirps *Bombycina* according to Singer (1986) based on its conspicuous fibrils and small spores.

Volvariella bombycina (Schaeff.) Singer is similar to *V. nivea* in having a white fibrillose pileus, but has longer pileal fibrils, longer and narrower basidiospoers (7.3–9.4 × 4.8–5.7 μm), and usually lignicolous habit (Fries 1821, Shaffer 1957). The substratum is of taxonomic importance in the genus *Volvariella* (Orton 1974). A variety named as *V. bombycina* var. *microspora* Dennis has similar spore size to that of the new species, but the pileus of the variety is lemon yellow and the basidiospores are narrower (6–7.5 × 4–5 μm) (Dennis 1961).

Among the other white and medium to large-sized species with basidiospores less than 10 μm long, similar species can be distinguished from *V. nivea* with the following differences: *V. hypopithys* (Fr.) M.M. Moser has a smaller basidiomes with a 2–5 cm broad pileus, thinner membranous volva, and pileus fibrils often squamulose and extending beyond the pileal margin (Shaffer 1957). *Volvariella striata* N.C. Pathak has a pileus with a central umbo and obviously striate margin and slightly longer and narrower (7.0–8.5 × 4.2–5.7 μm) basidiospores (Pathak 1975). *Volvariella castanea* (Massee) G.C. Rath has a glabrous, viscid pileus, and larger (8–10 × 8 μm) basidiospores (Rath 1963). Finally, *V. diplasia* (Berk. & Broome) Singer has a coloured volva, longer (7.5–10 × 4.7–6.5μm) basidiospores, and a lignicolous habit (Saccardo 1887, Pegler 1986).

Volvariella speciosa (Fr.) Singer and *V. acystidiata* N.C. Pathak are also macroscopically similar to the new species, but they have much larger basidiospores. In *V. speciosa* the basidiospores are (11.7–)13.4–18.1(–20.9) × (7.2–)8.3–10.3(–12.4) μm and the pileus is viscid (Shaffer 1957) while in *V. acystidiata* the basidiospores are 13–14.5 × 7.8–8.3 μm (Pathak 1975). The similar *V. reidii* Heinem. has much smaller (3.75–4.2 × 2.2–3.2 μm) basidiospores (Reid et al.1977, Heinemann 1978).

The rDNA-ITS (ITS1-5.8S-ITS2 segment) sequence with 801 bps of the new species (FJ749127) differs from all other known *Volvariella* sequences. Through

a Blast search against the GenBank DNA database, only 171 bps of 5.8S of the sequence can be compared with 309 max scores and 98% maximal percent identities to those of *V. bombycina* (EU920673, EF566874), and with 303 max scores and 98% maximal percent identities to those of *V. volvacea* (FJ379274, FJ379273, FJ379272, AY636051, AY636050, AY636049). The remaining parts (ITS1 and ITS2, occupying about 79% of the whole segment) of the sequence are so different that they are not comparable with the known sequences. Therefore, *V. nivea* is considered distinct.

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